

# The Future of Nuclear Power in the Wake of Fukushima

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# Disaster Strikes Fukushima

- Magnitude 9 earthquake strikes off the northeast coast of Japan on March 11, 2011
- Immediately following the earthquake, a massive tsunami hits Japan's coastline



# TEPCO's Fukushima Dai-ichi Nuclear Power Plant

- Six units with individual capacity between 460-1100 Net MWe
- On the day of the earthquake only Units 1-3 were in operation, Units 4-6 were shutdown for routine activities
- The earthquake successfully triggered automatic shutdowns at the Fukushima Dai-ichi plant
- Tsunami waves at the site exceeded designed protections by approximately 8 meters



# Tsunami Damage and Response

- Loss of emergency diesel generators on Units 1-5
- Respondents had severely limited communication and were forced to operate in near total darkness
- Generator on Unit 6 able to be tied into Unit 5 to supply backup power
- Loss of emergency power and damaged pumps led to loss of cooling at Units 1-3 in the first couple of days
- Hydrogen explosion in the cooling tanks led to release of radioactive material
- Cold shutdown announced on December 16, 2011 with the plant in a stable state and radioactive release under control



# Global Reaction

- Polling conducted by CNN/Public Opinion following Fukushima shows Americans remain favorable to the continued use of nuclear power
- Gamut of reactions worldwide, including:
  - Slovakia, Turkey, and the Netherlands continuing construction of proposed plants
  - Venezuela and Switzerland enacting a freeze on all nuclear power development projects
  - Germany announces it will shut down their 7 oldest nuclear reactors permanently and develop plans to shut down the remaining reactors by 2022, reversing a 2010 decision to extend their operating life by an average of 12 years
- Nuclear power is responsible for 14% of worldwide energy production



# Regulatory Impacts

- NRC task force issues report with 12 recommended improvements to NRC oversight of nuclear safety
- Union of Concerned Scientists issue suggested recommendations for the NRC
- In Europe, the Western European Nuclear Regulators' Association [WENRA] with the European Nuclear Safety Regulators Group [ENSREG] are developing site-specific emergency planning to account for two initiating events (such as an earthquake and tsunami)
- The International Atomic Energy Agency issued a report on Fukushima identifying 16 lessons from the incident that should be taken into account in future evaluations



# Impacts on the Nuclear Industry

- Siemens announces it will be withdrawing from the nuclear industry, however they will continue to make components (such as turbines) that are used in both nuclear and non-nuclear applications
- NRC delayed certification of Westinghouse's AP1000 reactor while evaluation of Fukushima was underway; AP1000 ultimately approved
- Black & Veatch's 2011 *Strategic Directions in the Electric Utility Industry* showed the percentage of respondents rating nuclear fuel disposal and storage as an issue they were "concerned" or "very concerned" with more than double from the prior year's survey
- Immediate effect in Japan shows nuclear power utilization falling to 38% in 2011, down from roughly 68% in 2010



# Safety of Nuclear Power Reactors

Three fundamental safety functions:

1. Control of Reactivity
  2. Fuel Cooling
  3. Confinement of Radioactivity
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# Cost Impacts of Fukushima

- Japan's government estimates the cost of nuclear power will be 50% higher than estimated seven years ago
- Similar trends resulted following the Three Mile Island incident





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# Summary and Questions

